

Architectural Glass Handbook V3.2

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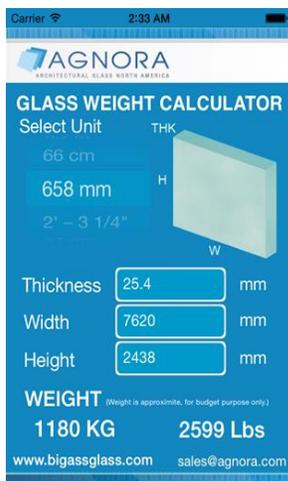
Company Overview

We're **AGNORA**, North America's leader in extra-large, high-precision glass fabrication. Our passion for glass and design is only surpassed by the quality of our products. While our clients initially come to us for what our leading-edge technology can do, it's our dedication to craftsmanship and exceptional service that keeps them coming back.

At **AGNORA**, we can help you realize even your most complex designs without compromising on creativity.

Processes we support in our 20, 500 m² - 220, 000 ft² Collingwood, Ontario, Canada facility:

Process	Thickness		Maximum Size	
CNC Machining	5 - 50 mm	3/16" - 2"	3.3 x 7.6 m	130 x 300 in
Straight Edge Polishing	5 - 100 mm	3/16" - 4"	3.3 x 7.6 m	130 x 300 in
Painting	5 - 25 mm	3/16" - 1"	2.3 x 7.6 m	84 x 300 in
Tempering	5 - 25 mm	3/16" - 1"	3.3 x 7.6 m	130 x 300 in
Heat Strengthening	5 - 12 mm	3/16" - 1/2"	3.3 x 7.6 m	130 x 300 in
Heat Soak Test	5 - 25 mm	3/16" - 1"	3.3 x 7.2 m	130 x 283 in
Laminating	6 - 100 mm	1/4" - 4"	3.3 x 7.6 m	130 x 300 in
Insulating (automated assembly)	12 - 90 mm	1/2" - 3 1/2"	3.3 x 7.6 m	130 x 300 in



Download our free **AGNORA** app glass weight calculator



Our Partners /Suppliers

High Performance coatings*
Diamant extra-clear*
Satinovo acid etch*
Miralite ecological mirrors*



*In 7000 X 3210 mm – 276” X 126”

Optiwhite Low Iron*
Extra-Long
Energy Advantage Low-e
Optiview Anti-reflective
Bronze



*In 7620 x 3302 – 300” x 130”

Starphire ultra-clear
Clear
Grey



Traction Glass
Velour acid etch
Texture acid etch pattern



Extra-clear PVB
SentryGlas



Vanceva Colour system
Vanceva White Collection
Saflex Acoustic



Opacicoat, Silicone based paint



Ceramic Enamel Paints and etch



Structural silicone



Glass Ceramic Ink Digital Printing



Technical Capabilities by process

Cutting

Thickness	3 mm to 25 mm	1/8" to 1"
Minimum Dimension	100 mm x 100 mm	4" x 4"
Maximum Dimension	6096 mm x 3300 mm	240" x 130"
Maximum Weight	1260 Kg	2775 Lbs
Shape	Rectangle, 104 catalog shapes, .dxf files	
Tolerance	± 0.5 mm	±1/32"

Edgework - Single Edger

Glass Thickness	3 mm to 100 mm	1/8" to 4"
Minimum Dimension	350 mm x 180 mm	14" x 7"
Maximum Dimension	7620 mm x 3300 mm	300" x 130"
Maximum Weight	600 Kg	2100 Lbs
Maximum Linear Weight	350 Kg / m	235 Lbs / ft
Tolerance	± 1.5 mm	±1/16"
Shape	Straight lines	

Edgework - CNC

Glass Thickness	3 mm to 25 mm	1/8" to 1"
Minimum Dimension	350 mm x 180 mm	14" x 7"
Maximum Dimension	7620 mm x 3300 mm	300" x 130"
Maximum Weight	600 Kg	2100 Lbs
Shape	Rectangle, 104 catalog shapes, .dxf files	
Tolerance	± 0.5 mm	±1/32"

Paint (Roller Coater)

Glass Thickness	3 mm to 19 mm	1/8" to 3/4"
Minimum Dimension	350 mm x 180 mm	14" x 7"
Maximum Dimension	7620 mm x 2130 mm	300" x 84"
Maximum Weight	600 Kg	1320 Lbs

Tempering

Glass Thickness	5 mm to 25 mm	3/16" to 1"
Minimum Dimension	400 mm diagonal	16" diagonal
Maximum Dimension	7620 mm x 3300 mm	300" x 130"

Heat Strengthening

Uncoated Glass Thickness	5 mm to 12 mm	3/16" to 1/2"
Coated Glass	5 mm to 10 mm	3/16" to 3/8"
Minimum Dimension	400 mm diagonal	16" diagonal
Maximum Dimension	7620 mm x 3300 mm	300" x 130"

Heat Soak Test

Glass Thickness	5 mm to 25 mm	3/16" to 1"
Maximum Dimension	7620 mm x 3300 mm	283" x 130"
Heat Soak Standard	EN 14179 – 1 Third party certified	

Laminating

Overall Thickness	6 mm to 100 mm	¼" tp 4"
Minimum Dimension	100 mm x 100 mm	4" x 4"
Maximum Dimension	7620 mm x 3300 mm	300" x 130 "
Maximum Weight	2500 Kg	5500 Lbs

Automated Insulated Glass assembly

Overall Thickness	12 mm to 90 mm	½" to 3 ½"
Configuration	Double or triple insulated	
Maximum thickness for middle lite	6 mm	¼"
Minimum Dimension	350 mm x 180 mm	14" x 7"
Maximum Dimension with gas	7620 mm x 3300 mm	236" x 130"
Maximum Weight	2500 Kg	5500 Lbs
Maximum Linear Weight	200 Kg / m	134 Lbs / ft
Step Side 1	50 mm	2"
Step Side 2-3-4	140 mm	5 ½"
Gas	Argon available for all units (even step units)	

Please contact AGNORA for larger sizes than indicated

Fabrication, Polishing and Edging

With the most sophisticated and precise machines on the market, **AGNORA** provides CNC fabrication, polishing and edging capabilities across a wide range of applications. **AGNORA** has the largest CNC Intermac machines in North America and the largest single-edger machine in the world. Our craftsmen are able to apply custom shapes and angles that were once considered impossible in the glass industry.

This capability is useful for projects calling for high precision and hole alignment on glass fins and balustrades. Our fabrication abilities give you new freedom to design your projects.



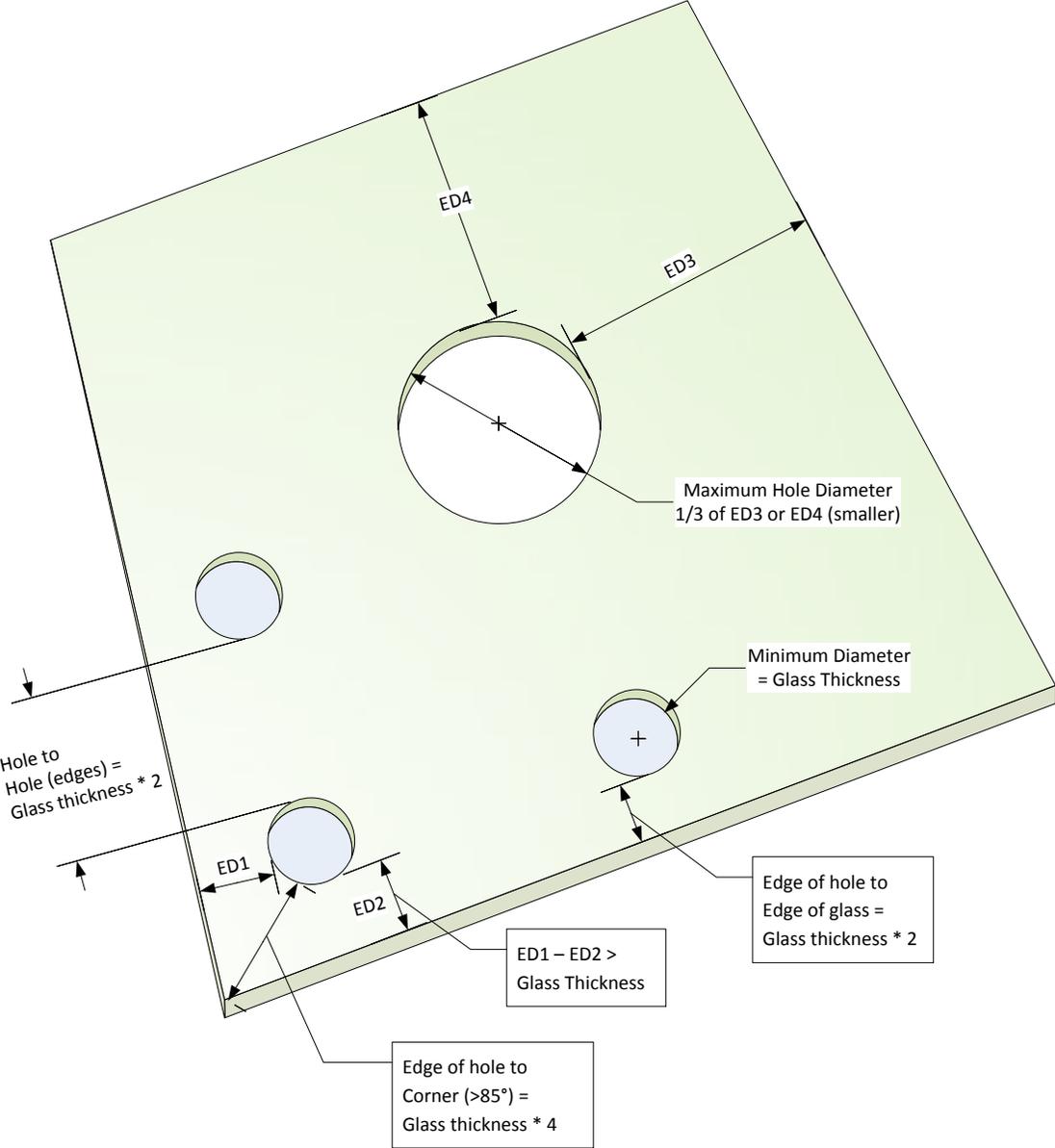
AGNORA +

- All our heat treated laminates are run through CNC for alignment of components
- Horizontal processing guarantees the tightest accuracy
- Largest single edge polisher in the world, can polish 100 mm – 4” thick
- CAD files to glass
- Special polishing compound makes edges water- like

Fabrication

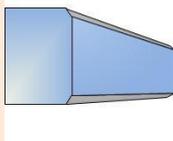
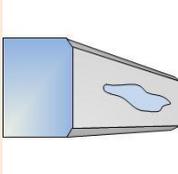
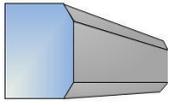
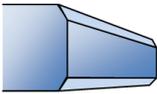
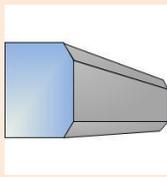
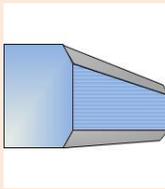
Holes and Notches dimensions and location guidelines

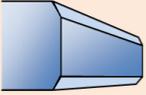
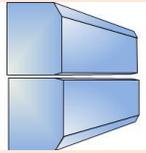
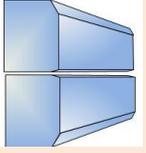
When working with heat treated glass, thermodynamic laws command the geometry of the holes and notches. These are described in ASTM C1048.04 paragraph 7.9. Here is a visual reminder of the basics.



Edging Options

We use the most detailed description of edge work on the market to ensure that our finishes matches your expectations. You will see these names on our drawings, quotes and order acknowledgements.

Category	Name	Picture	Description	Machine	Precision	Usage
Minimum edge	Belt edge arrised		Diamond belt arrised	KSR	± 0.5 mm	All large (>6 m ²) glass IGU, non-exposed tempered edge Good dimensional tolerance
Minimum edge	Belt flat ground		Diamond Belt flat ground. Some spots remain "as cut"	KSR	± 0.5 mm	Non-exposed tempered edge, used often on 10 mm and coated glass. Good dimensional tolerance
Diamond Tool	Diamond tool flat ground		Dull edge with a chamfer on each side	Single Edger	± 1.5 mm	Normal dimensional precision for thick (>=12 mm) tempered glass. Can only be used on straight edge
Diamond Tool	Diamond high polish		Shiny edge with a chamfer on each side	Single Edger	± 1.5 mm	Normal dimensional precision Best clarity. Can only be used on straight edge
CNC	CNC flat ground		Dull edge with a chamfer on each side.	Intermac	± 0.5 mm	High dimensional precision for thick (>=12 mm) tempered glass, used in cutout and holes
CNC	CNC polish		Shiny edge with lines parallel to surfaces and chamfers on each side	Intermac	± 0.5 mm	High dimensional precision for thick (>=12 mm) tempered glass, shiny but not perfect

CNC	CNC high polish		Shiny edge and chamfers on each side. Use of cerium wheel.	Intermac	± 0.5 mm	High dimensional precision for thick (>=12 mm) tempered glass, Best polish and precision
CNC	Perfect_Align®		Shiny edge used for tempered laminates.	Intermac	± 0.5 mm	High Quality edge for tempered laminates to obtain a good interlayer trim
CNC	Ultimate SG Finish®		As perfect align with SG-Structury Glass structured interlayer	Intermac	± 0.5 mm	Perfect Align edgework PLUS proprietary process for butter-smooth SG interlayer edge

We also offer front and back mitres using the same finish, machines and precision.

Lamination

Overview

Laminated glass is a safety glazing material that holds together when shattered. Laminated glass may crack upon impact, but the glass fragments adhere to the protective interlayer rather than falling free and potentially causing injury. Typically laminated glass is constructed with two plies of glass permanently bonded together with polyvinyl butyral (PVB). Those plies can be annealed, heat strengthened or tempered. AGNORA can laminate up to 8 layers of glass and 100 mm – 4” thickness.

Laminated glass has been used since 1939 in automobile windshields. Its use in architectural projects started in the 1960s in applications where there is a possibility of human impact or where the glass could fall if shattered. Skylight glazing typically uses laminated glass. This is the best technology in hurricane-resistant construction; laminated glass is often used in exterior storefronts, curtain walls and windows. The use of ionoplast interlayer opens up a new era in structural glass design. Advanced interlayers gives design freedom for translucency, colours, printed interlayers, etc.

Advantages of laminated glass

- Safest glass available – retains fragments
- Remains intact, transparent and functional even if broken – perfect for storefront
- Provides safety with annealed glass – no roller wave distortion
- Design freedom: colour, translucency, opaque, solar control
- Burglar retardant
- Bullet resistant when multi-layers of glass are used
- Protection from flying debris in hurricane
- Protection for bomb blast
- Cuts 99% of Ultra-Violet light
- Improves acoustic properties



Our fully automated clean room allows us to offer the best glass layer alignment on the market

AGNORA +

- Largest automated line in North America
- Our process includes both the traditional nip method and complex vacuum bagging techniques
- Very precise layer alignment
- We are certified by the Safety Glass Certification Council [SGCC](#)

Interlayers in stock

Brand	Product	Size	
Kuraray/ Trosifol			
BG R20	Extra-Clear 0.38 mm – 0.015"	3300 mm	130"
BG R20	Extra-Clear 0.76mm – 0.030"	3300 mm	130"
BG R20	Extra-Clear 1.52mm – 0.060"	3300 mm	130"
Kuraray			
SentryGlas	Clear 1.52mm - 0.060" (Sheet)	2510 mm x 5890 mm	99" x 232"
SentryGlas	Clear 0.89 mm - 0.035" (Roll)	1828 mm	72"
Eastman			
Saflex Standard	Clear 0.38 mm - 0.015"	2460 mm	96"
	Clear 0.76 mm – 0.030"	2460 mm	96"
	Grey 0.38 mm – 0.015"	2460 mm	96"
	Bronze 0.38 mm – 0.015"	2460 mm	96"
Vanceva Foundation Colour	Coral Rose - 1	2460 mm	96"
	Aquamarine - 2	2460 mm	96"
	Smoke Grey - 3	2460 mm	96"
	Sahara Sun - 4	2460 mm	96"
	Ruby Red - 5	2460 mm	96"
	Sapphire - 6	2460 mm	96"
	Evening Shadow - 7	2460 mm	96"
	Golden Light - 8	2460 mm	96"
Vanceva Specialty Colour	Deep Red - C	2460 mm	96"
	True Blue - D	2460 mm	96"
	Ocean Grey - H	2460 mm	96"
Vanceva Tranluscent White	Arctic Snow (TL 65%) - 9	2460 mm	96"
	Cool White (TL 81%) - A	2460 mm	96"
Vanceva Opaque Colour	Polar White (TL 8%) - F	2460 mm	96"
	Absolute Black - G	2460 mm	96"
Saflex Acoustic	Clear QS41	3210 mm	126"
Bridgestone			
Evasafe	Clear 0.38 mm – 0.015"	2200 mm	86"

Vanceva Colour System

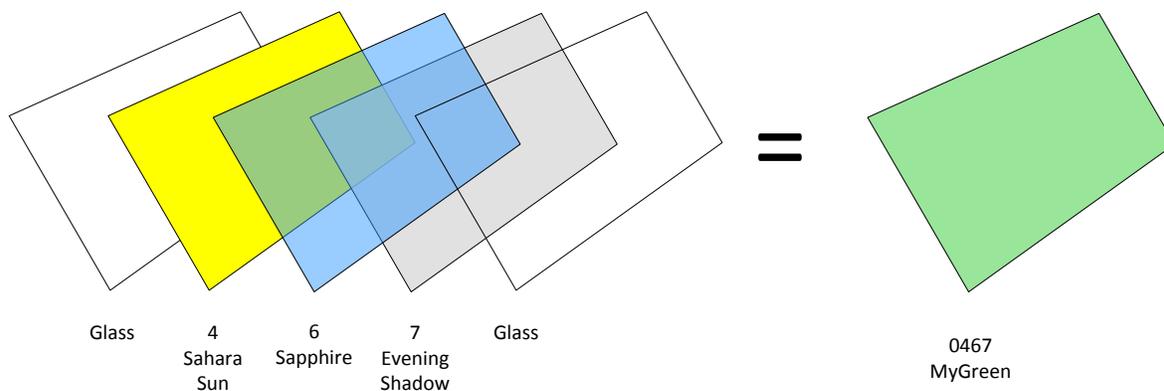
How the System Works

The Vanceva colour system is based on a foundational palette of 4 key colours (pink, blue, grey and yellow) in two light transmission levels to create a base palette of 8 colours. Similar to the CMYK colour system most often used in printing, the Vanceva colour system allows architects, designers and glass fabricators the ability to layer several different colour interlayers together, in different intensity levels, to create thousands of colour possibilities. Click on this [link](#) to access Vanceva Colour Studio and design your own colour.

Vanceva Colour Formulation Codes

One to four sheets of interlayer can be used to construct custom coloured laminated glass. Since the maximum number of interlayers is four, each Vanceva colour has been assigned a four-digit number. Each number or letter represents a layer from the foundational palette used to create all Vanceva colour interlayer combinations.

The illustration below details an example of a three layers Vanceva colour code, and each corresponding colour associated with the final glass make up. An example of a one layer combination would be Vanceva 0006, while an example of a two layer colour combination would be Vanceva 0026, etc.



Vanceva Translucent White

In both interior and exterior applications, Vanceva white interlayers offer a full range from total opacity for private settings to translucent designs to let the light shine in. They provide superior, uniform colour, which results in a unique white safety glass. The interlayer is layered between two pieces of glass, so they are easy to maintain and clean. Vanceva interlayers are available worldwide with easy access to replacement glass. Laminated glass made with Vanceva white interlayers delivers effective protection from harmful UV radiation, glare, solar energy transmittance and heat build-up. The interlayers screen out up to 99 percent of damaging UV light to help retard colour fading and the deterioration of fabrics and furnishings.

Vanceva Cool White

If a project requires a frosted look for design or privacy, a translucent effect can be created with Vanceva Cool White. Cool White has an 81% light transmission level – allowing for light to enter the space while maintaining privacy.

Vanceva Arctic Snow

For a more private feel without complete opacity, a more translucent effect can be created by using Vanceva Arctic Snow. Arctic Snow has a 68% light transmission level. Multiple layers of Arctic Snow can be used to reduce light transmittance even further--down to 29%.

Vanceva Opaque Colour

Vanceva Polar White

Vanceva Polar White has superior opacity and uniformed coloured surface. Polar White is also ideal when designers want to achieve two different colours of glass in a single unit (i.e. white on one side and opaque True Blue on the other) which allows for even greater design flexibility. Polar White has a light transmittance level of 8%.

Vanceva Absolute Black

Absolute Black has excellent opacity and a deep, neutral uniform coloured surface compared to any black glass product on the market. Compared to back painted black glass, Absolute Black provides superior aesthetics and visual quality (no pinholes) plus the additional benefits only laminated glass offers. Absolute Black has a light transmittance level of 0%.



The largest glass autoclave in North America



Precise nip control keeps layers aligned during de-airing

Special Lamination

Cutout in the interlayer



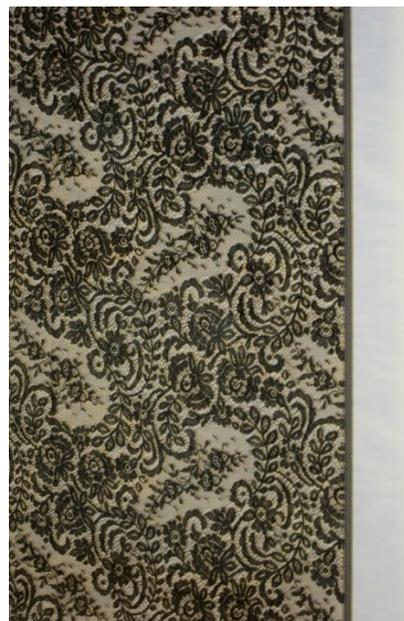
Vanceva Absolute Black interlayer with a clear window cutout for television - 2235 mm x 4775 mm - 88" X 188"

Embedded material

AGNORA is open to experiment with different materials to create beautiful and artistic laminates. Here are two examples of unique projects.



Metallic grid – 210 W 18th New York



French Lace – Dolce & Gabbana, New York

Painting

AGNORA use roller coater technology to apply Opacicoat and Ceramic Paint.



Applications

- Decorative
 - Solid colour
 - Translucent whites
 - Simulated acid etch
 - Sandblasted glass imitation
- Wall cladding
- Kitchen backsplash
- Kitchen counter tops
- Spandrel
 - Single Pane
 - Clear or Coloured glass, or glass with a “hard coat” Low E
 - Insulated Glazing
 - Allows to keep the same look as the vision area
 - Allows to use uniform curtain wall system for both vision and spandrel
 - Most often made of the same composition as the vision glass
 - Application of the ceramic paint or Opacicoat paint on the interior lite (surface #4)

AGNORA +

- Strict process control allows us to create very even coatings so we can make beautiful etch or sandblast imitation
- We are certified by ICD
- Working with Opacicoat, we can match any colour, including flashy reds and purples
- We stock numerous colours that may be required on short notice

Digital Ceramic Printing on Glass

Our printing process applies ceramic ink directly to the glass surface. After printing, the glass is heat treated in our oven. This fuses the ceramic ink permanently to the surface of the glass. Following heat treatment, the printed glass can be opacified, laminated, and insulated. Inkjet printing directly on glass is both time and cost efficient, and opens up creative options for artists and designers.

Artwork requires extensive work to set up. Discuss your project with us early in the creative process. Together we will review the feasibility of the reproduction and discuss the best methods to reproduce your artwork.

Specifications

- Minimum panel size: 305 x 305mm
- Maximum panel size: 3300 x 7180mm
- Glass thickness: 5 to 19mm
- Recommend substrate: Extra-clear (low iron) glass

Image & Text Specification

- Print will be held back 4mm from the edge
- Text positioned on clear glass should be no smaller than 12pt
- Text positioned on colored backgrounds should be no smaller than 14pt and set at a heavier font weight



Samples and Proofing

A production sample takes time and care to produce. Complex projects may require multiple rounds of sampling to achieve the desired result and understand expectations. We encourage designers to factor this time into their project schedule. If experimentation is required, allow ample time for testing from an early stage.

Photographic Files (Bitmap)

Traditional artwork requires professional photography to ensure the most accurate color reproduction.

Photographs should be supplied at the largest size possible, in RGB color space. If working on a large scale project, please do not scale artwork to the finished size, as we will handle this in-house.

Graphic Images (Vector)

Try to limit your color palette when using vector graphics as this makes conversion for printing more cost effective.

Keep your artwork neatly organized into named layers for easy separation, as we often need to apply printer settings to these objects.

Saving for Print

TIFF, JPEG, or PSD

Format 300 dpi resolution

RGB color space. All layers unlocked

Saving for Print

EPS, AI, or PDF Format RGB color space All layers unlocked

Text converted to outlines

All spot colors converted to RGB or removed from artwork

Heat Treatment



In order to provide greater resistance to thermal, mechanical stresses, and achieve specific break patterns for safety glazing applications, annealed float glass can be subjected to a heat-treating process.

Fully Tempered (FT)

Tempered or toughened [UK] glass is a type of safety glass processed by controlled thermal treatments. It increases its strength 4 – 5 times compared to annealed glass. Tempering shrinks the faces of the glass thus putting the outer surfaces into compression and the inner surfaces into tension. This imprisoned energy causes the glass, when broken, to shatter into small granular chunks instead of splintering into jagged shards. The granular chunks are less likely to cause injury.

AGNORA FT glass meets the following standards:

- ASTM C 1048-04 Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass
- ANSI Z97.1- 2009 – Safety Glazing Materials Used in Buildings
- Consumer Product Safety Act 16 CFR 1201 2012 vol2
- CAN CGSB 12.1-M90 – Canadian Standard for Tempered or Laminated Safety Glass

Heat Strengthened Glass (HS)

Heat Strengthened Glass is produced with surface compression levels less than fully tempered glass. These lower compression levels yield a product that is generally twice as strong as annealed glass of the same thickness, size and type. Heat Strengthened Glass will fracture into large fragments, similar to annealed glass breakage. With its unique furnace configuration, **AGNORA** can HS up to 12 mm thick uncoated glass and 10 mm coated glass.

AGNORA HS glass meets the following standards:

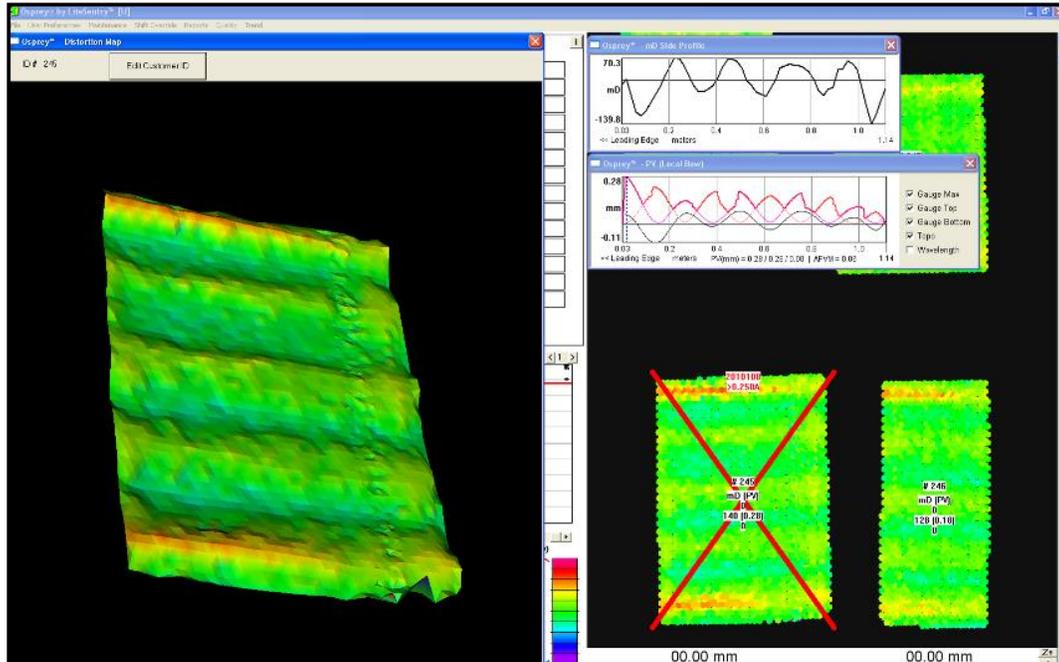
- ASTM C 1048- 04 Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass

AGNORA +

- We are certified by the Safety Glass Certification Council [SGCC](#)
- We are uniquely able to Heat Strengthen 12 mm glass with our full convection furnace
- Laser engraved safety logo: precise and unnoticeable
- Ultra flat roller wave, see below

Optical Quality Control

AGNORA uses an Osprey [LiteSentry](#) system to aid in the quality analysis of localised distortion. Using CCD cameras, the device is capable of measuring the observed distortion or curvature of the glass. This measurement is made in (milli) diopters. The apparatus also calculates the traditional peak to valley and edge curl values based on these measurements.



The distortion measurements are displayed as an average and as a colour map of the entire sheet of glass. In addition, each piece can be chosen and manipulated for better viewing or further analysis. Each of the included measurement methods can be used to determine pass/fail for the individual glass lites.

Heat Soak Testing

Fully tempered glass may break without warning due to the expansion of nickel sulfide inclusions (NiS) present within float glass. The best way to avoid this risk is to use annealed glass. However, sometimes tempered glass is required for its added strength.



Although the incidence of tempered glass breakage due to these inclusions is rare, greater publicity of their occurrence has resulted in an increased awareness of this phenomenon.

In all cases where falling glass debris are dangerous or when the value of the glass or its replacement are significant, **AGNORA** recommends performing a heat soak test to provide the added assurance that significant spontaneous breakage will not occur. Heat Soaking remains the only practical way to uncover NiS inclusions.

AGNORA acquired an oversized Heat Soak Oven to test its tempered glass. After tempering, we reheat the glass to 290°C - 555°F for two hours. Most glass containing NiS will shatter during this stressful procedure, this is why it is called destructive testing.

Because there is no North American standard for this procedure, we use the most credible testing method: the European standard EN14179-2. Our oven is regularly calibrated by a European certified company.



Insulated Glass

Insulated glass is two or three plies of glass enclosing a hermetically sealed air space. Insulating glass is the most effective way to increase a window's thermal performance by reducing the heat gain or loss. To create this hermetically sealed and dehydrated space, the glass panes are separated by a spacer bar filled with a desiccant to absorb internal moisture.

All our insulated glass units are double sealed with a primary seal of polyisobutylene and a secondary seal of silicone. We prefer to use stainless steel bar for their superior thermal and mechanical performances but we can provide aluminum spacers to match existing conditions. We bend our spacer bars to limit the number of junctions therefore improving the gas retention.

Using high performance coatings, argon gas and stainless steel spacers, we can improve the insulation quality. The result is a significant reduction in both heating and air conditioning costs in a facility. By combining different glass into an IGU, we control and enhance:

- Light level
- External and internal colour and reflection
- Solar energy control
- Thermal Insulation
- Safety
- Security
- Acoustic insulation
- Fading factors

Although an IGU might look simple and low tech, its design, components and craftsmanship will determine its longevity. At **AGNORA**, we want our product to have a useful life that matches your façade life. This is why we insist on a Center of Glass Deflection of 19 mm – ¾" as calculated using the ASTM E1300-09. We have prepared a [table](#) giving you a basic idea of glass composition vs. glass size.



We own one of the world largest automated IGU assembly line.

AGNORA +

- Vertical and automatic assembly for jumbo size units
 - Guarantee flat units
 - No pressure equalization required
- Automated four-step sides with argon
- Argon atmosphere press for over 95% fill rate
- Precise spacer shape bending, no corner keys, less junctions

Spacer Bars and Sealant

Spacer bars

We maintain inventory of the following

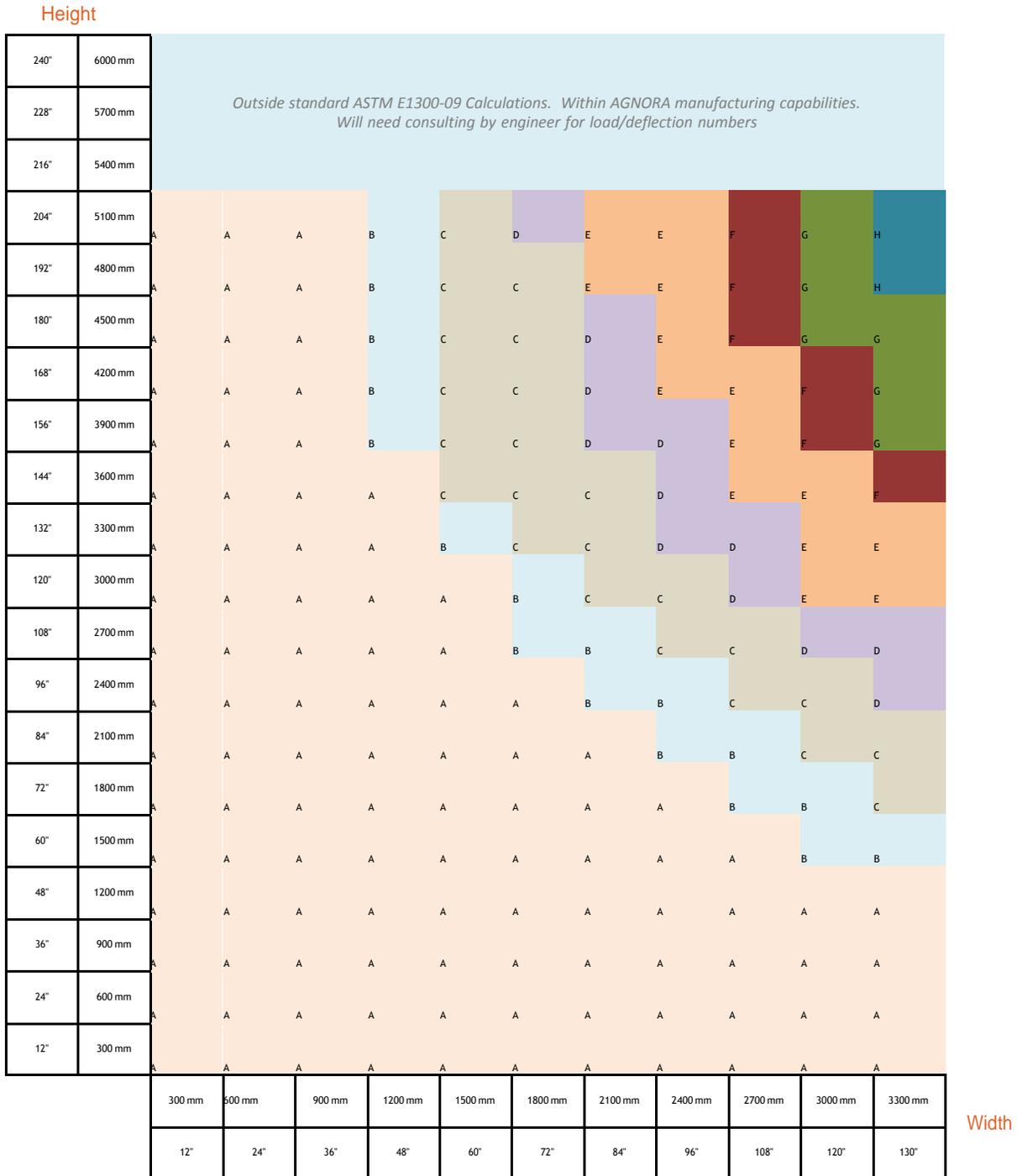
	Aluminum mill finish	Aluminum Black (dark bronze)	Stainless Steel mill finish	Stainless Steel Black
8 mm – 9/32"	✓	✓		
10 mm – 3/8"	✓	✓	✓	✓
12 mm – 1/2"	✓	✓	✓	✓
15 mm – 37/64"	✓	✓	✓	✓
16 mm – 5/8"	✓	✓		
18 mm – 11/16"	✓	✓	✓	✓
20 mm – 25/32"	✓	✓		

Silicone

We use black and grey Momentive IGS3723 two part insulating glass silicone sealant.

Wind Load Calculation Guidelines

AGNORA fabricates the highest quality and largest insulated glass units. We offer IGU warranty only if Center of Glass Deflection is smaller than $\frac{3}{4}$ " using ASTM E1300-09 standard. The charts below provide a guideline glass configuration based on its overall dimensions. This chart is a guideline using a short duration load (3 sec.) = 1.4 Kpa - 29 PSF and long duration (30 days) 730 Pa -15 PSF.



Recommended Glass Thickness for Wind Load Calculation Guidelines

This is only based on deflection values, glass can be annealed or tempered.

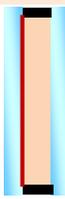
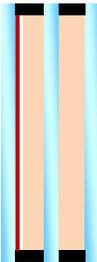
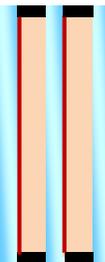
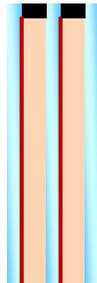
Double Glazed Units Composition Legend

Annealed or tempered

	Composition	Overall Thickness	Weight per m ²	Weight per ft ²	
A	6 mm (1/4") 13 mm (1/2") spacer 6 mm (1/4")	25 mm - 1"	30 Kg	6.1 Lbs	0.984252
B	6 mm (1/4") 13 mm (1/2") spacer 10 mm (3/8")	29 mm - 1 1/8"	40 Kg	8.2 Lbs	1.141732
C	10 mm (3/8") 13 mm (1/2") spacer 10 mm (3/8")	33 mm - 1 5/16"	50 Kg	10.2 Lbs	1.299213
D	10 mm (3/8") 15 mm (5/8") spacer 12 mm (1/2")	37 mm - 1 1/2"	55 Kg	11.3 Lbs	1.456693
E	10 mm (3/8") 15 mm (5/8") spacer 15 mm (5/8")	40 mm - 1 9/16"	63 Kg	12.8 Lbs	1.574803
F	12 mm (1/2") 15 mm (5/8") spacer 15 mm (5/8")	42 mm - 1 5/8"	68 Kg	13.8 Lbs	1.653543
G	12 mm (1/2") 15 mm (5/8") spacer 19 mm (3/4")	46 mm - 1 13/16"	78 Kg	15.9 Lbs	1.811024
H	15 mm (5/8") 15 mm (5/8") spacer 19 mm (3/4")	50 mm - 1 15/16"	85 Kg	17.4 Lbs	1.968504

Performance of Insulated Glass Units vs. Cost

	Thickness	Light Trans.	SHGc	Winter U BTU/h-ft ² -°F	Winter U W/m ² -°K	Cost factor
Single Glazing						
Clear 6 mm	6 mm - 1/4"	89%	0.82	1.00	5.8	35%
Double Glazing Clear						
Clear 6 mm Air 13 mm Clear 6 mm	25 mm - 1"	79%	0.70	0.47	2.7	86%
Double Glazing Pyrolytic (Hard) Coated low-e						Baseline
Pilkington Energy Advantage 6 mm Air 13 mm Clear 6 mm	25 mm - 1"	73%	0.62	0.33	1.9	100%
Double Glazing High Performance (Soft) low-e						
SGG Planitherm Ultra N 6 mm Air 13 mm Clear 6 mm	25 mm - 1"	78%	0.53	0.29	1.7	103%
Double Glazing High Performance (Soft) low-e + Argon						
SGG Planitherm Ultra N 6 mm Argon 90% 13 mm Clear 6 mm	25 mm - 1"	78%	0.53	0.25	1.4	105%

	Thickness	Light Trans.	SHGc	Winter U BTU/h-ft ² -°F	Winter U W/m ² -°K	Cost factor
Double Glazing High Performance (Soft) Solar Control low-e + Argon						
SGG Coolite SKN174 Argon 90% 13 mm Clear 6 mm	 25 mm - 1"	68%	0.37	0.25	1.4	108%
Double Glazing High Performance (Soft) Solar Control low-e, fourth surface low-e and argon						
SGG Coolite SKN174 Argon 90% 13 mm Pilkington Energy Advantage 6 mm	 25 mm - 1"	62%	0.36	0.20	1.1	125%
Triple Glazing, Solar control one coating, Argon						
SGG Coolite SKN174 Argon 90% 13 mm Clear 6 mm Argon 90% 13 mm Clear 6 mm	 43 mm - 1 3/4"	61%	0.34	0.19	1.0	148%
Triple Glazing, Solar control + low-e coating, Argon						
SGG Coolite SKN174 Argon 90% 13 mm SGG Planitherm Ultra N 6 mm Argon 90% 13 mm Clear 6 mm	 43 mm - 1 3/4"	59%	0.33	0.14	0.8	166%
Triple Glazing , triple coating, Argon, the Works!						
SGG Coolite SKN174 Argon 90% 13 mm SGG Planitherm Ultra N 6 mm Argon 90% 13 mm Pilkington Energy Advantage 6 mm	 43 mm - 1 3/4"	55%	0.31	0.12	0.7	181%

Coated Glass Comparison

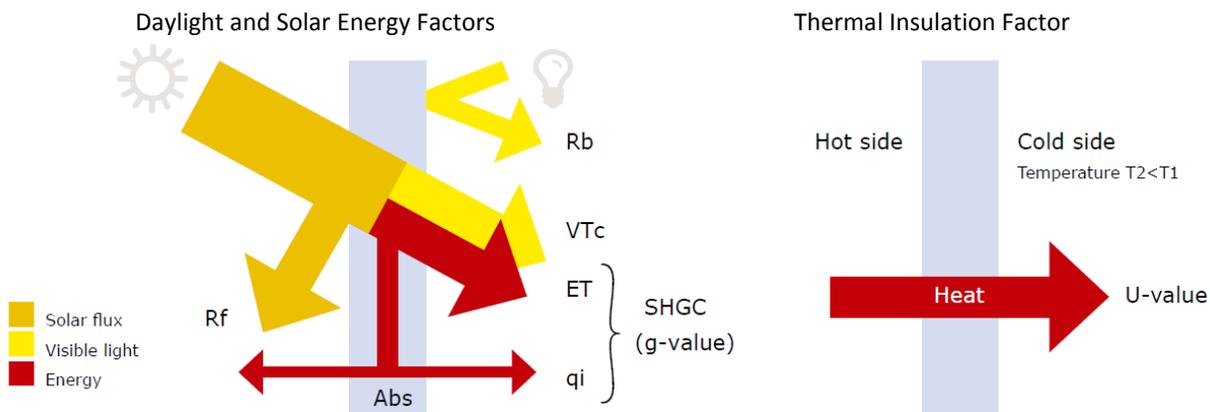
Manufacturer	Product	LBNL ID	Stock	Coat. Pos.	EXT	INT	VTc	Rf	SHGC	Tdw-ISO	Winter U BTU/h ft ² °F	Winter U W/m ² °C	Max H X L
Saint-Gobain	Planitherm Ultra N low iron #2	11055	Yes	2	X	X	82%	11%	0.58	0.74	0.25	1.4	126" x 236"
Saint-Gobain	Planitherm Ultra N low iron #3	11055	Yes	3	X	X	82%	12%	0.63	0.74	0.25	1.4	126" x 236"
Saint-Gobain	Planitherm Ultra N #2	11040	Yes	2	C	C	78%	11%	0.53	0.66	0.25	1.4	126" x 236"
Saint-Gobain	Planitherm Ultra N #3	11040	Yes	3	C	C	78%	12%	0.57	0.66	0.25	1.4	126" x 236"
AGC	Energy Select 63	1040	0	2	C	C	77%	12%	0.54	0.63	0.26	1.5	96" x 144"
Cardinal	LoE 180 #3	2194		3	C	C	76%	15%	0.63	0.60	0.26	1.5	96" x 144"
Cardinal	LoE 180 #2	2194		2	C	C	76%	15%	0.60	0.60	0.26	1.5	96" x 144"
Viracon	VRE1-85 #3	6050	0	3	C	C	76%	13%	0.58	0.61	0.27	1.5	84" x 165"
Viracon	VRE1-85 #2	6050	0	2	C	C	76%	13%	0.54	0.61	0.27	1.5	84" x 165"
PPG	Solarban 60 on Starphire	5349	0	2	X	X	74%	11%	0.41	0.58	0.24	1.4	96" X 144"
AGC	Energy Select 73 #2	1035	0	2	C	C	74%	16%	0.63	0.63	0.29	1.6	96" x 144"
AGC	Energy Select 73 #3	1036	0	3	C	C	74%	17%	0.67	0.63	0.29	1.6	96" x 144"
AGC	Comfort E ² #3	910	0	3	C	C	73%	16%	0.67	0.61	0.31	1.7	130" x 204"
AGC	Comfort E ² #2	910	0	2	C	C	73%	14%	0.62	0.61	0.31	1.7	130" x 204"
Pilkington	Energy Advantage #2	9924	Yes	2	C	C	73%	16%	0.62	0.62	0.29	1.6	130" X 240"
Pilkington	Energy Advantage #3	9924	Yes	3	C	C	73%	17%	0.67	0.62	0.29	1.6	130" X 240"
Guardian	Climaguard Neutral 78/65 #3	3271	0	3	C	C	73%	15%	0.63	0.63	0.27	1.6	100" X 144"
Guardian	Climaguard Neutral 78/65 #2	3271	0	2	C	C	73%	13%	0.59	0.63	0.27	1.6	100" X 144"
Saint-Gobain	Cool-lite SKN 074 on low iron	11062	Yes	2	X	X	71%	11%	0.39	0.61	0.25	1.4	126" x 236"
Viracon	VE1-2M	6046	0	2	C	C	70%	11%	0.37	0.51	0.25	1.4	84" x 165"
PPG	Solarban 60	5284	0	2	C	C	70%	11%	0.39	0.53	0.24	1.4	100" X 144"
AGC	Energy Select 40	1050	0	2	C	C	70%	12%	0.38	0.53	0.24	1.4	96" x 144"

Manufacturer	Product	LBNL ID	Stock	Coat. Pos.	EXT	INT	VTc	Rf	SHGC	Tdw-ISO	Winter U BTU/h ft ² °F	Winter U W/m ² °C	Max H X L
Guardian	SN 68	3110	0	2	C	C	67%	11%	0.37	0.55	0.25	1.4	102" X 168"
PPG	Solarban 70XL	5439	0	2	X	C	64%	12%	0.27	0.43	0.24	1.4	96" X 144"
AGC	Energy Select 36	1055	0	2	C	C	63%	13%	0.35	0.48	0.25	1.4	96" x 144"
Cardinal	LoE ³ 366	2157		2	C	C	63%	11%	0.27	0.41	0.24	1.4	96" x 144"
Viracon	VNE1-63	6261	0	2	C	C	62%	10%	0.28	0.41	0.24	1.4	84" x 165"
AGC	Energy Select R42	1045	0	2	C	C	62%	26%	0.42	0.48	0.25	1.4	96" x 144"
Guardian	SN 62	3116	0	2	C	C	62%	11%	0.31	0.44	0.24	1.4	100" X 144"
Guardian	SNX 62/27	3413	0	2	C	C	61%	11%	0.26	0.39	0.24	1.4	100" X 144"
AGC	Energy Select 28	1070	0	2	C	C	61%	13%	0.28	0.44	0.24	1.4	96" x 144"
Pilkington	Eclipse Advantage	9909	0	2	C	C	60%	29%	0.55	0.48	0.31	1.7	130" X 204"
Saint-Gobain	Coolite XTREME 60/28	11403	Yes	2	C	C	60%	14%	0.24	0.47	0.24	1.3	126" x 236"
Saint-Gobain	Cool-lite SKN 165	11060	0	2	C	C	60%	16%	0.30	0.48	0.24	1.3	126" x 236"
PPG	Solarban 67	5476	0	2	C	C	54%	19%	0.29	0.40	0.24	1.4	96" X 144"
Guardian	SN 54	3114	0	2	C	C	53%	13%	0.27	0.39	0.24	1.4	100" X 144"
Viracon	VRE1-59	6173	0	2	C	C	53%	31%	0.33	0.40	0.25	1.4	84" x 165"
Guardian	SNX 51/23	26143	0	2	C	C	51%	12%	0.23	0.38	0.24	1.4	100" X 144"
Saint-Gobain	Cool-lite SKN 154	11061	0	2	C	C	50%	18%	0.25	0.39	0.24	1.3	126" x 236"
Viracon	VUE1-50	6298	0	2	C	C	49%	11%	0.25	0.35	0.24	1.4	84" x 165"
Viracon	VRE1-54	6206	0	2	C	C	47%	32%	0.30	0.37	0.25	1.4	84" x 165"
Saint-Gobain	Cool-lite KS 150	11165	0	2	C	C	45%	29%	0.33	0.39	0.26	1.5	126" x 236"
Viracon	VRE1-46	6172	0	2	C	C	43%	34%	0.28	0.35	0.25	1.4	84" x 165"
Guardian	SNR 43	3425	0	2	C	C	43%	27%	0.22	0.35	0.24	1.4	100" X 144"
PPG	Solarban R100	5404	0	2	C	C	42%	32%	0.23	0.34	0.25	1.4	100" X 144"
Viracon	VE1-42	6163	0	2	C	C	37%	19%	0.31	0.35	0.27	1.5	84" x 165"
Viracon	VRE1-38	6171	0	2	C	C	36%	44%	0.23	0.29	0.25	1.4	84" x 165"

Notes

- Composition: 6 mm - 1/4" / 12.7 mm - 1/2" 90 % Argon / 6 mm - 1/4"
- Products are sorted by Light Transmission
- EXT = Exterior lite; INT = Interior lite C= Clear X=Extra-Clear Low Iron
- All those calculations were performed on Windows 7.2 using IGDB 37.0
- Environmental Conditions: NFRC 100-2010
- Items in bold are stocked inventory items

Definition of key performance indicator



Vtc	Visible Light Transmission The percentage of visible light that is transmitted through the glass. The higher the percentage the more daylight.
Rf/VLR	Reflection front - Visible Light Reflection The percentage of visible light that is reflected by the glass surface. The higher the percentage the more reflection.
SHGCc	Solar Heat Gain Coefficient or Solar Factor The measure of the total solar energy transmittance entering a building through the glazing as heat gain. The lower the SHGC the better the glass restricts heat energy transmission.
SCc	Shading Coefficient $SC = SHGC/0.87$
U value	U Value or U Factor A measure of the heat gain or loss through glass due to the difference between indoor and outdoor temperatures. The lower the number, the better the performance at reducing heat gain and heat loss. The imperial number is the reciprocal of the R-Value.
Tdw-ISO	Damage weighted transmittance Quantifies the ability of glass to reduce fading by measuring the effects of both transmitted UV and visible light.

Cleaning Architectural Glass Products

The following “Dos” and “Do Nots” are offered as a supplement to the Glass Association of North America ([GANA](#)) Glass Informational Bulletin— Proper Procedures for Cleaning Architectural Glass Products:

- The following are things to DO:
 - DO clean glass as soon as dirt and residue appear visibly.
 - DO determine if coated glass surfaces are exposed.
 - DO exercise special care when cleaning coated glass surfaces.
 - DO avoid cleaning tinted and coated glass surfaces in direct sunlight.
 - DO start cleaning at the top of the building and continue to lower levels.
 - DO soak the glass surface with a clean water and soap solution to loosen dirt and debris.
 - DO use a mild, nonabrasive commercial window cleaning solution.
 - DO use a squeegee to remove all of the cleaning solution.
 - DO dry all cleaning solution from window gaskets, sealants and frames.
 - DO clean one small window area and check to see if procedures have caused any damage.
 - DO be aware of and follow the glass supplier’s specific cleaning recommendations.
 - DO caution other trades against allowing other materials to contact the glass.
 - DO watch for and prevent conditions that can damage the glass.
 - DO read the entire GANA Bulletin on glass cleaning before starting to clean glass.
-
- The following are things to NOT do:
 - DO NOT start cleaning without reading the entire GANA Bulletin on glass cleaning.
 - DO NOT use scrapers of any size or type for cleaning glass.
 - DO NOT allow dirt and residue to remain on glass for an extended period of time.
 - DO NOT begin cleaning glass without knowing if a coated surface is exposed.
 - DO NOT clean tinted or coated glass in direct sunlight.
 - DO NOT allow water or cleaning residue to remain on the glass or adjacent materials.
 - DO NOT begin cleaning without rinsing excessive dirt and debris.
 - DO NOT use abrasive cleaning solutions or materials.
 - DO NOT allow metal parts of cleaning equipment to contact the glass.
 - DO NOT trap abrasive particles between the cleaning materials and the glass surface.
 - DO NOT allow other trades to lean tools or materials against the glass surface.
 - DO NOT allow splashed materials to dry on the glass surface.

Glass Quality Standards

Item	Specification	Description
1	ANSI Z97.1	American National Standard for Glazing Materials Used in Buildings Safety Performance Specifications and Methods of Test
2	ASTM C1036	Standard Specifications for Flat Glass
3	ASTM C1172	Standard Specification for Laminated Architectural Flat Glass
4	ASTM C1048	Standard Specification for Heat-Treated Glass - Kind HS, Kind FT, Coated and Uncoated Glass
5	ASTM C1376	Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Glass
6	ASTM C162	Standard Terminology of Glass & Glass Products
7	ASTM E1300	Standard Practice for Determining Minimum Thickness and Type of Glass required to resist a specific load
8	ASTM E773	Standard Test Method for Seal Durability of Sealed Insulating Glass Units
9	ASTM E774	Standard Specification for Sealed Insulating Glass Units
10	ASTM E2188	Standard Test Method for Insulating Glass Unit Performance
11	ASTM E2189	Standard Test Method for Testing Resistance to Fogging in Insulating Glass Units
12	ASTM E2190	Standard Specification for Insulating Glass Unit Performance and Evaluation
13	CPSC 16 CFR 1201	Safety Standard for Architectural Glazing Materials

Canada

Item	Specification	Description
1	CAN/CGSB 12.1 M90	Tempered or Laminated Safety Glass
2	CAN/CGSB 12.2 M90	Flat, Clear Sheet Glass
3	CAN/CGSB 12.3 M90	Flat, Clear Sheet Glass
4	CAN/CGSB 12.4 M90	Flat, Heat Absorbing Glass
5	CAN/CGSB 12.8 M90	Insulating Glass Units
6	CAN/CGSB 12.10 M90	Light and Heat Reflecting Glass

Cheat notes

Useful tables

in	2	4	8	16	32	64	mm
0.016						1/64	0.4
0.031					1/32		0.8
0.047						3/64	1.2
0.063				1/16			1.6
0.078						5/64	2.0
0.094					3/32		2.4
0.109						7/64	2.8
0.125			1/8				3.2
0.141						9/64	3.6
0.156					5/32		4.0
0.172						11/64	4.4
0.188				3/16			4.8
0.203						13/64	5.2
0.219					7/32		5.6
0.234						15/64	6.0
0.250		1/4					6.4
0.266						17/64	6.7
0.281					9/32		7.1
0.297						19/64	7.5
0.313				5/16			7.9
0.328						21/64	8.3
0.344					11/32		8.7
0.359						23/64	9.1
0.375			3/8				9.5
0.391						25/64	9.9
0.406					13/32		10.3
0.422						27/64	10.7
0.438				7/16			11.1
0.453						29/64	11.5
0.469					15/32		11.9
0.484						31/64	12.3
0.500		1/2					12.7
0.516						33/64	13.1
0.531					17/32		13.5
0.547						35/64	13.9
0.563				9/16			14.3
0.578						37/64	14.7
0.594					19/32		15.1
0.609						39/64	15.5
0.625			5/8				15.9
0.641						41/64	16.3
0.656					21/32		16.7
0.672						43/64	17.1
0.688				11/16			17.5
0.703						45/64	17.9
0.719					23/32		18.3
0.734						47/64	18.7
0.750			3/4				19.1
0.766						49/64	19.4
0.781					25/32		19.8
0.797						51/64	20.2
0.813					13/16		20.6
0.828						53/64	21.0
0.844						27/32	21.4
0.859						55/64	21.8
0.875			7/8				22.2
0.891						57/64	22.6
0.906					29/32		23.0
0.922						59/64	23.4
0.938				15/16			23.8
0.953						61/64	24.2
0.969					31/32		24.6

Area conversion

1 m² = 10.764 ft²
 1 ft² = 0.0929 m²

Mass conversion

1 Kg = 2.205 Lbs
 1 Lb = 0.4536 Kg
 1 ton (US) = 907 Kg = 2000 Lbs
 1 Tonne = 1000 Kg = 2205 Lbs

Distance conversion

1 Inch = 25.4 mm = 2.54 cm .0254 m
 1 Foot = 12 inches = 30.48 cm .3048 m
 1 m = 39.37 inches = 100 cm 1000 mm

Density

Water = 1.0
 Glass = 2.5

1 Liter or 1000 cm³ of Water weighs 1.0 Kg
 1 Liter or 1000 cm³ of Glass weighs 2.5 Kg

For Glass

1000 mm X 1000 mm X 1 mm = 1 liter or 2.5 Kg
 1000 mm X 1000 mm X 6 mm = 6000 cm³ or 15 Kg

Glass weights Thickness

Area	Thickness	Weight (Kg)	Weight (Lbs)
1.0 m ²	1.0 mm (1/32")	2.5 Kg	5.5 Lbs
1.0 m ²	6.0 mm 1/4"	15.0 Kg	33.1 Lbs
1.0 m ²	10.0 mm 3/8"	25.0 Kg	55.1 Lbs
1.0 m ²	12.0 mm 1/2"	30.0 Kg	66.2 Lbs
1.0 m ²	15.0 mm 5/8"	37.5 Kg	82.7 Lbs
1.0 m ²	19.0 mm 3/4"	47.5 Kg	104.7 Lbs

Area	Thickness	Weight (Kg)	Weight (Lbs)
1.0 ft ²	1.0 mm 1/32"	0.23 Kg	0.51 Lbs
1.0 ft ²	6.0 mm 1/4"	1.39 Kg	3.07 Lbs
1.0 ft ²	10.0 mm 3/8"	2.32 Kg	5.12 Lbs
1.0 ft ²	12.0 mm 1/2"	2.79 Kg	6.15 Lbs
1.0 ft ²	15.0 mm 5/8"	3.48 Kg	7.68 Lbs
1.0 ft ²	19.0 mm 3/4"	4.41 Kg	9.73 Lbs



Download our free app to help you convert units and calculate weights.





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OUR OVERSIZE CAPABILITIES:

Process	Thickness		Maximum Size	
CNC Machining	5 - 50 mm	3/16" - 2"	3.3 x 7.6 m	130 x 300 in
Straight Edge Polishing	5 - 100 mm	3/16" - 4"	3.3 x 7.6 m	130 x 300 in
Painting	5 - 19 mm	3/16" - 3/4"	2.3 x 7.6 m	84 x 300 in
Tempering	5 - 19 mm	3/16" - 3/4"	3.3 x 7.6 m	130 x 300 in
Heat Strengthening	5 - 12 mm	3/16" - 1/2"	3.3 x 7.6 m	130 x 300 in
Heat Soak Test	5 - 19 mm	3/16" - 3/4"	3.3 x 7.2 m	130 x 283 in
Laminating	6 - 100 mm	1/4" - 4"	3.3 x 7.6 m	130 x 300 in
Insulating (automated assembly)	12 - 90 mm	1/2" - 3 1/2"	3.3 x 7.6 m	130 x 300 in